

**LAB 3: Serial Interfacing Using I<sup>2</sup>C**  
**Assignment Due: May 2, 2021**

**Objective:** In this lab, you will use I<sup>2</sup>C to communicate with an on-board Bosch BMA222 acceleration sensor. Your application program will detect the XY tilt of your board based on BMA222 readings and use the tilt to control an icon on your OLED display. You can also use a Saleae logic probe to capture and monitor SPI and I<sup>2</sup>C signal waveforms for debugging purpose.

**New Equipment Needed Per Group**

- 1 Adafruit OLED Breakout Board - 16-bit Color 1.5" (product id: 1431) on small breadboards
- 1 Saleae USB Logic Analyzer
- Jumper wires

**Note:** Do not lose the shorting blocks (jumpers) that come with the board. They are used to configure different hardware functions on the board, and may be needed for this and future labs. Unused shorting blocks should be kept on the board attached to a single header pin.

**Resources (Technical Data Sheets)**

Refer to the following technical documents:

- CC3200 Technical Reference Manual
- CC3200 LaunchPad User Guide
- CC3200 LaunchPad Schematic
- CC3200 Datasheet
- SSD1351 128 RGB x 128 Dot Matrix OLED/Common Driver with Controller Advance Information
- OLED Display Module Product Specification (Doc No. SAS1-D038-A)
- Bosch BMA222 Data sheet

**Part I. Using I<sup>2</sup>C to communicate with the on-board BMA222 accelerometer**

In this part, you will interface to the Bosch BMA222 accelerometer on the CC3200 Launchpad using I<sup>2</sup>C. You will then write an application program that uses the acceleration data to control a graphical icon on your OLED.

**1. Implement i2c\_demo project on a CC3200 LaunchPad**

As a starting point, you should study, import, build, and test the i2c\_demo project on a CC3200 LaunchPad. The project is documented at

[http://processors.wiki.ti.com/index.php/CC32xx\\_I2C\\_Application](http://processors.wiki.ti.com/index.php/CC32xx_I2C_Application)

and in the CC3200 SDK

(C:\ti\CC3200SDK\_1.2.0\cc3200-sdk\docs\examples\ CC32xx I2C application.pdf).

In addition, you should study the Bosch BMA222 Data sheet to understand how the acceleration sensor can be used. For example, the acceleration data is described in Section 4.4.1 and includes the following basic information:

“The width of acceleration data is 8 bits given in two’s complement representation. The 8 bits for each axis are given in registers (0x03) acc\_x, (0x05) acc\_y and (0x07) acc\_z.”

You can use the i2c demo program to see what kinds of acceleration data you get for various tilt angles using the readreg command as shown below, where the BMA222 has I<sup>2</sup>C device address 0x18. The following three commands read the acceleration data for the x, y and z axes, respectively.

```
cmd# readreg 0x18 0x3 1
cmd# readreg 0x18 0x5 1
cmd# readreg 0x18 0x7 1
```

Another way to read the data is to read multiple bytes at once, such as in the command below. This command will read the new data flag and the acceleration data for the x, y and z axes, respectively.

```
cmd# readreg 0x18 0x2 6
```

## 2. Debugging I<sup>2</sup>C waveforms using a Saleae logic

Set up your Saleae logic probe to capture I<sup>2</sup>C waveforms by enabling the I<sup>2</sup>C Analyzer. You will need to connect three wires: Ground, I2C\_SCL, and I2C\_SDA. To avoid damaging the electronics, you should always make the signal connections with both the CC3200 LaunchPad and the Saleae logic probe **unpowered**. As before, make sure that the ground symbol on the bottom of the Saleae module is aligned with the grey wire and connect the grey wire to one of the CC3200 GND pins. You can check the pinmux.c file in the i2c\_demo project to find out which pins are used for I2C\_SCL and I2C\_SDA. Connect two of the Saleae probes, such as the Black and Brown leads, to the appropriate header pins. Double-check your ground and signal connections **before** you turn on the power to the CC3200 LaunchPad.

### Verification

An example screen-shot of an I2C waveform is shown below.



### 3. Application Program

In this part, you will use the accelerometer to move a small “ball” (a filled circle icon) with a radius of about 4 pixels ( $\pm 2$ ) around on the OLED display. The accelerometer output can be used to determine the accelerometer pitch and roll orientation angles, which can be used to control the motion of the ball left, right, up and down. Rotating the accelerometer around the x-axis (roll) will move the ball left and right. The steeper the roll angle, the faster the ball should scroll across the OLED display. Similarly, rotating the accelerometer around the y-axis (pitch) will move the ball up and down on the OLED display, where the speed of the ball scrolling up and down on the display will be proportional to the pitch angle. Since the Z measurement is not used, you can disable or ignore the Z measurements. When the ball reaches the edge of the OLED display, it should not move any further in that direction. That is, it should not scroll off the screen, but should stop at any edge.

Initially, you should display the ball at the center of your OLED display. When the CC3200 Launchpad is flat, the ball should be stationary on the display. Note that you should be able to tilt the x and y axes simultaneously to move the object in any arbitrary direction on the display. For example, you should be able to move the object from the center directly to any of the four corners. The scrolling rate should be fairly slow for small tilts so that you can precisely control the position of your object.

#### **Deliverables:**

1. The video in \*.mp4 format showcasing that:
  - a. you can move the ball up, down, left and right across the OLED display by tilting the CC3200 Launchpad accelerometer about the x- and y- axes. Show that you can move the ball from the center of the display to each corner of the display and then back to the center.
  - b. you can control the speed of the ball’s motion by changing the tilt angle about the x- and y- axes. The ball should be at maximum speed when the tilt angle is 90 degrees (i.e. freefall). At maximum speed, it should take about 2 seconds to move the ball from top to bottom or side to side on the display. When the accelerometer is barely tilted, the ball should move very slowly. You should be able to precisely control the motion of the ball on the OLED display, stopping it at any location on the display. You should be able to move the ball at any arbitrary angle across the OLED display.
2. The video should also capture you while explaining and demonstrating the working of the circuit. If you have made extra connections, please explain it to us through the video. For example, you can ask someone at home to film you or use the selfie camera to record yourself explaining the working and then use the back camera to capture the demonstration of the circuit. You can also create your own PowerPoint slides and walk us through it for explaining the circuit connection and your idea.
3. Try to limit the video to maximum of 5 minutes. The video and audio clarity should be decent enough for us to judge your work.
4. Zip the source files and video and upload it to the canvas, make sure the zip is not locked and the source files can be opened using text editor software. Please comment the code wherever necessary.
5. Late submission policy: 0-3 days with no penalty, 4-7 days with 25% reduction each day. Submission later than a week will not be accepted.